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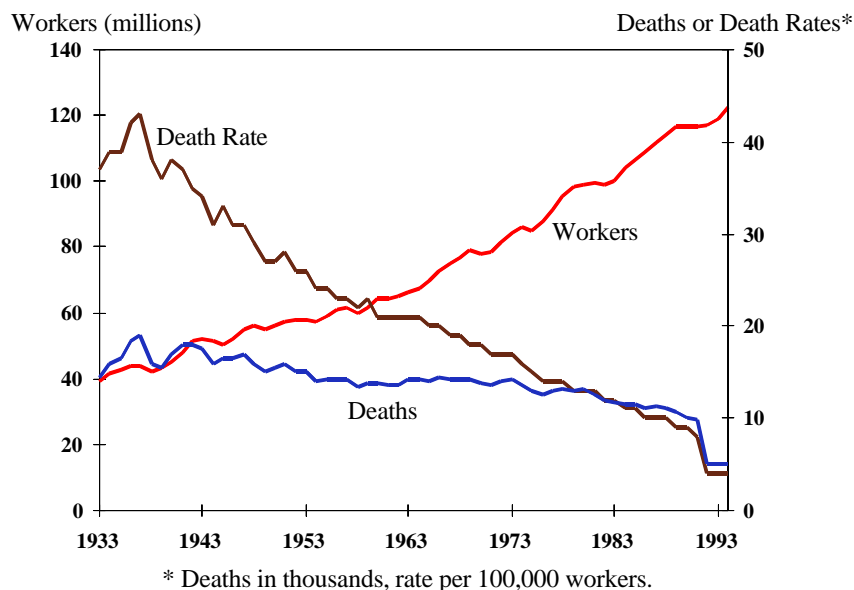
**BARRIER ANALYSIS: A TOOL FOR SAFETY MANAGEMENT**

The Office of Operating Experience Analysis and Feedback (EH-33) has recently been developing tools for safety management at DOE facilities. Barrier analysis is one such tool that has important applications both as a proactive aid in safe work planning and in the systematic after-the-fact investigations of incidents and accidents. The adaptability of barrier analysis to simple risk analyses enhances the usefulness of this tool for applications that go beyond anecdotal safety assessments of past events or future work. The remarkable progress made in workplace safety in the past few decades (see Figure 1) is persuasive evidence that effective safety management can pay rich dividends in terms of a safer and more productive workplace.

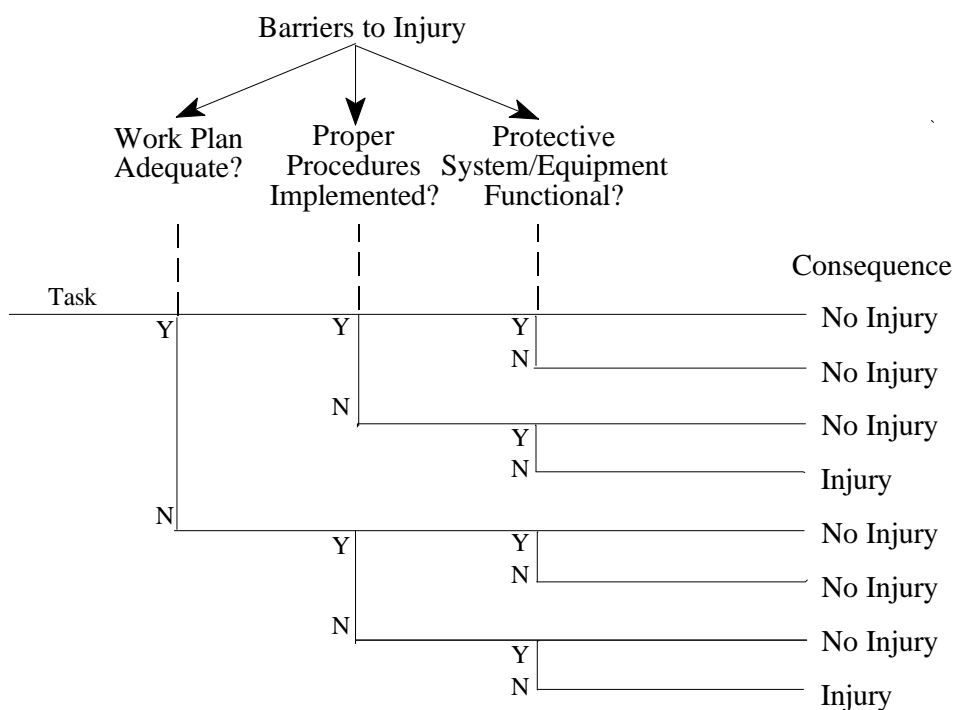
Barrier analysis consists of the three following steps: (1) identification of hazards that are associated with a specific task, (2) identification and implementation of a set of effective barriers that protect the worker from these hazards in the course of the work, and (3) estimating the probabilities of failure of the barriers to arrive at an estimate of the risk of injury. The first two steps in the barrier analysis require a knowledge of the steps involved in the task and of the environment in which the task is to be performed. For someone familiar with these aspects of the work, they are fairly simple to implement; and these two steps in the barrier analysis should form a part of the conventional work planning process. The third step in the barrier analysis serves to evaluate whether the barriers to be implemented are expected to perform as desired. This third step requires somewhat specialized knowledge of the reliability and effectiveness of barriers. To aid in the implementation of barrier analyses, EH-33 is planning to develop a handbook that will aid in identifying hazards, identifying the corresponding barriers, and determining the effectiveness and reliability of the barriers to be implemented.

Figure 2 provides a schematic illustration of barrier analysis. For the purposes of illustration, it is assumed that the barriers to injury consist of: (1) an adequate work plan, (2) proper implementation of procedures, and (3) proper functioning of protective systems or equipment. It is also assumed that either the second barrier (proper procedure implementation) or the third barrier (proper functioning of system or equipment) can prevent injury. The simplified event tree in Figure 2 shows the combination of barrier failures that lead to injury. If the barrier failure probabilities are known, the event tree also provides an estimate for the probability of injury. The estimated probability provides a means for determining whether the barriers selected are adequate. The importance of the first barrier, an adequate work plan, is not made fully clear in this schematic illustration. Barrier analyses of actual incidents and accidents have shown that adequate work planning plays a crucial role, often reducing the probability of injury by an order of magnitude or more by reducing the failure probability of subsequent barriers.

Event trees such as the one shown in Figure 2 can be constructed either for incidents or accidents that have occurred in the past, or for some task that is to be undertaken in the future. In the former application, the analysis provides important insights or “lessons learned” from the incident. In the latter application, the analysis provides important proactive safety insights into the task to be performed.



**Figure 1 Workers, Deaths and Death Rates, United States, 1933-1994** (from "Accident Facts," National Safety Council, 1995 Edition)



**Figure 2 Schematic Illustration of Barrier Analysis**